

CUT & GLUE SORT



ANGLES OF ELEVATION AND DEPRESSION

Can It Be Found?

Twelve sightings in words · three rows · nothing to calculate

FREE

¹ A straight kite string is 200 feet long. The angle of elevation from its stake on level ground to the kite is 52° . How high is the kite?	² From 120 feet away on level ground, the angle of elevation to the top of a tower is 34° . Find the angle at the top of the tower between the tower and the line of sight.	³ The angle of depression from a lighthouse keeper's eyes to a boat on the level sea is 39° . How far is the boat from the foot of the lighthouse?
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Row 1. It can be found, and it needs sin, cos or tan.

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Row 2. It can be found without sin, cos or tan.

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Row 3. It cannot be found. Not enough is given.

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Cut & Glue Sort — how to run it

25 minutes, including the cutting

1. **Hand out pages 3 and 4**, one of each per student, with scissors and glue. Nothing else is needed.
2. **Say this once:** *“For each piece, list what is given. Can the thing asked be found? If yes, does it need sin, cos or tan? Do not work out any numbers.”*
3. **Check a sheet in ten seconds:** every row gets four pieces.

Student sheets	pages 3 and 4, one of each per student. Page 3 has drawings of the two angles and the three rows. Page 4 has the pieces.
Answers	page 5.

Each piece is a sighting in words, with a question: someone looks up or down at something along a straight line of sight. Nothing is calculated. A right triangle can be solved from two sides, or from one side and one acute angle. Row 1 holds pieces where a length and an angle must be linked, so sin, cos or tan is needed. Row 2 holds pieces that need only 90° minus an angle, or the Pythagorean theorem. Many students reach for a ratio when two sides are given and a third is asked. Others reach for the theorem when an angle is given.

The last row is the most important. Its pieces look like the others, with numbers and a question. Piece 9 gives two angles and no length. Two angles fix the shape of the triangle but never its size. In two pieces a length is given that is not a side of the triangle: an eye height, or a cliff under the person who looks up. Ask a student: *“Which of these numbers is a side of your triangle?”*

Guessing rules, such as sorting by how many numbers a piece prints, place at most six pieces correctly.



This is the free lesson this activity came from. The worksheet, the full answers and the lesson plan are on it, at three levels of difficulty.

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Cut & Glue Sort — can it be found?

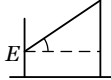
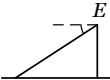
Elevation and depression

Name _____

Period _____

Date _____

Each piece on the next page tells a sighting and asks for one thing. **Picture the right triangle. Can the thing asked be found from what is given? If yes, does it need sin, cos or tan? Glue the piece in its row.** Do not work out any numbers. A right triangle can be solved from two sides, or from one side and one acute angle.

	Angle of elevation: from the horizontal line at the eye E up to the line of sight.		Angle of depression: from the horizontal line at the eye E down to the line of sight.
The dashed line is the horizontal line at the eye. If the eye is on level ground, the ground is that line.	The line of sight runs from the eye to the thing seen. It is always the hypotenuse.	Ground is level. Cliffs, towers, poles and walls stand straight up.	

Row 1. It can be found, and it needs sin, cos or tan.

Row 2. It can be found without sin, cos or tan.

Row 3. It cannot be found. Not enough is given.

Cut & Glue Sort — the sightings

Cut along the dashed lines

Cut out the twelve pieces. Glue each one in its row on the other sheet.

1 A straight kite string is 200 feet long. The angle of elevation from its stake on level ground to the kite is 52°. How high is the kite?	2 From 120 feet away on level ground, the angle of elevation to the top of a tower is 34°. Find the angle at the top of the tower between the tower and the line of sight.	3 The angle of depression from a lighthouse keeper's eyes to a boat on the level sea is 39°. How far is the boat from the foot of the lighthouse?	4 Kim's eyes are 5 feet above level ground. She looks up at the top of a tower that is 120 feet tall. Find the angle at the top of the tower between the tower and her line of sight.
5 A keeper's eyes are 80 feet above the level sea. A boat is 300 feet from the foot of the lighthouse. Find the angle of depression from her eyes to the boat.	6 A balloon is 90 feet above level ground. Its straight rope to a stake is 150 feet long. How far is the stake from the point right below the balloon?	7 The angle of depression from a hiker's eyes on a cliff to a tent below is 21°. Find the angle at her eyes between the cliff and the line of sight.	8 A drone camera is 140 feet above a level field. The straight line from the camera to a cone is 260 feet long. Find the angle of depression from the camera to the cone.
9 From a point on level ground, the angle of elevation to the top of a pole is 39°. The angle at the top, between the pole and the line of sight, is 51°. How far is the point from the foot of the pole?	10 Ana lies on level ground, 150 feet from the foot of a straight tower. The angle of elevation from Ana to the top of the tower is 28°. How tall is the tower?	11 From the top of a 60-foot cliff, the angle of elevation to a plane is 25°. How high above the ground is the plane?	12 Leo's eyes are 40 feet above a level river. A boat is 96 feet from the point right below his eyes. How long is the straight line from his eyes to the boat?



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Each row holds four pieces. Every piece is printed again here, with the reason.

1 **It can be found, and it needs sin, cos or tan.**

1. A straight kite string is 200 feet long. The angle of elevation from its stake on level ground to the kite is 52° . How high is the kite? *Why:* One side and one acute angle are given. The height is opposite the 52° and the string is the hypotenuse, so $\sin 52^\circ$ is needed.
5. A keeper's eyes are 80 feet above the level sea. A boat is 300 feet from the foot of the lighthouse. Find the angle of depression from her eyes to the boat. *Why:* Two sides are given and an angle is asked. The angle of depression is at her eyes, below the horizontal line there. That line is parallel to the sea, so the same angle stands at the boat. From the boat, the height is opposite and the distance is adjacent, so $\tan$ is needed: the height over the distance, then the inverse key.
8. A drone camera is 140 feet above a level field. The straight line from the camera to a cone is 260 feet long. Find the angle of depression from the camera to the cone. *Why:* Two sides are given and an angle is asked. The angle of depression is at the camera, below the horizontal line there. That line is parallel to the field, so the same angle stands at the cone. From the cone, the height is opposite and the line of sight is the hypotenuse, so $\sin$ is needed.
10. Ana lies on level ground, 150 feet from the foot of a straight tower. The angle of elevation from Ana to the top of the tower is 28° . How tall is the tower? *Why:* One side and one acute angle are given. The height is opposite the 28° and the distance is adjacent, so $\tan 28^\circ$ is needed.

2 **It can be found without sin, cos or tan.**

2. From 120 feet away on level ground, the angle of elevation to the top of a tower is 34° . Find the angle at the top of the tower between the tower and the line of sight. *Why:* The two acute angles add up to 90° , so the angle is $90^\circ - 34^\circ$. The 120 feet is not needed.
6. A balloon is 90 feet above level ground. Its straight rope to a stake is 150 feet long. How far is the stake from the point right below the balloon? *Why:* Two sides are given, and the rope is the hypotenuse. The Pythagorean theorem gives the third side.
7. The angle of depression from a hiker's eyes on a cliff to a tent below is 21° . Find the angle at her eyes between the cliff and the line of sight. *Why:* The horizontal line at her eyes and the cliff make a right angle at her eyes. So the angle asked is $90^\circ - 21^\circ$.
12. Leo's eyes are 40 feet above a level river. A boat is 96 feet from the point right below his eyes. How long is the straight line from his eyes to the boat? *Why:* Two legs are given and the line of sight is the hypotenuse. The Pythagorean theorem gives it.

3 **It cannot be found. Not enough is given.**

3. The angle of depression from a lighthouse keeper's eyes to a boat on the level sea is 39° . How far is the boat from the foot of the lighthouse? *Why:* No length is given. A lighthouse of any height has a boat at the angle of 39° , near or far.
4. Kim's eyes are 5 feet above level ground. She looks up at the top of a tower that is 120 feet tall. Find the angle at the top of the tower between the tower and her line of sight. *Why:* The triangle has one side, $120 - 5 = 115$ feet. Her distance from the tower is not given, and one side fixes no angle.
9. From a point on level ground, the angle of elevation to the top of a pole is 39° . The angle at the top, between the pole and the line of sight, is 51° . How far is the point from the foot of the pole? *Why:* Only angles are given. Two angles fix the shape of the triangle but not its size.
11. From the top of a 60-foot cliff, the angle of elevation to a plane is 25° . How high above the ground is the plane? *Why:* The cliff is not a side of the triangle that holds the 25° . That triangle has only an angle, and the plane can be near or far.

To check a piece with a student, list what is given that is a side or an acute angle of the right triangle. Two sides, or one side and one acute angle, are enough. Then ask: does the answer link an angle to lengths? If yes, it needs sin, cos or tan. If it needs only the other acute angle, or a third side from two sides, it does not.